REMARKS

The Office Action mailed December 28, 2004, has been received and reviewed. Claims 1 through 6, 8 and 9 are currently pending in the application. Claims 1 through 6, 8 and 9 stand rejected. No claims are amended. Reconsideration is respectfully requested.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on U.S. Patent No. 5,883,001 to Jin et al. in View of U.S. Patent No. 4,943,539 to Wilson et al.

Claims 1 through 6, 8 and 9 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Jin et al. (U.S. Patent No. 5,883,001) in view of Wilson et al. (U.S. Patent No. 4,943,539). Applicant respectfully traverses this rejection, as hereinafter set forth.

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, **the prior art reference (or references when combined) must teach or suggest all the claim limitations.** The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

Jin discloses a two-step etching process for making a multilayer metallization structure. A metal contact 23 is formed over a region 19. A dielectric barrier 24 of SiON or silicon nitride is formed over the metal contact 23. Then, a flowable glass dielectric layer 25 is deposited over which another dielectric layer 27 is formed. A PSG layer 28 is formed on the dielectric layer 27 and a photoresist layer 30 is formed over the PSG layer 28.

To create an opening to the metal contact 23, the photoresist is patterned and an opening 26 is etched which exposes the PSG layer 28. (Jin, Figs. 4 and 5). An isotropic etch is performed through the PSG layer 28 and part of the dielectric layer 27 using 10:1 BOE. (Jin, Fig. 6, col. 7, lines 31-35). *The isotropic etch creates tapered sidewalls 35, 36 on the opening 26.* (Jin, col. 6, lines 37-39)(emphasis added). Jin next discloses an anisotropic etch through the

dielectric layer 27, glass dielectric layer 25 and barrier dielectric layer 24 to expose the metal contact 23. The anisotropic etch consists of a main etch and an overetch to remove oxide residue from the metal contact 23, but which may induce charging damage to the device. (Jin, col. 7, lines 51-55). A wet etch is used to minimize damage, but create tapered sidewalls. (Jin, col. 6, lines 58-62 and lines 37-39).

Wilson discloses a two-step etching process for making a multilayer metallization structure. A first interconnect layer 12 is formed on a dielectric layer 11. The first interconnect layer 12 is covered by a first metal layer 13 which is then covered by a sacrificial layer 14. (Wilson, col. 3, lines 49-51). Preferably, the first interconnect layer comprises aluminum copper alloy, the first metal layer 13 comprises TiW or TiSi and sacrificial layer 14 comprises aluminum alloy or titanium nitride. (Id., col. 3, lines 53-57; col. 4, lines 4-5). The layers 12, 13, 14 are patterned and an interlayer dielectric 16 is formed thereover. (Wilson, FIG. 2). The dielectric layer 16 is patterned and dry etched to expose the sacrificial layer 14. (Id. col. 4, lines 17-24; FIG. 3). A second *isotropic* etch, preferably comprising a solution of nitric acid, phosphoric acid, and acetic acid, is then performed. (Id. col. 4, lines 34-38). The isotropic etch removes residual backsputtered material 19 and etches sacrificial layer 14 in both a downward and sideways direction to create a single "T" shaped void. (Cf. Wilson, FIGs. 3 and 4). Additionally, the wet etch chemical "removes residual backsputtered material incorporated into the polymer film" (*Id.* at lines 51-55).

Each of independent claims 1 through 6 and 8 through 9 of the presently claimed invention recite a "residue-free contact opening," a substantially damage-free metal containing conductive pad and "residue-free sidewalls", which limitations are not taught or suggested by the proposed combination of Jin and Wilson. Jin discloses removing *oxide* residues from the metal contact 23 by an overetch but lacks any disclosure of removing *metal* residue from the opening 26. (Jin, col. 7, lines 50-55). Thus, the method disclosed by Jin will not result in the claimed structure. Jin notes the disclosed method will "***minimize*** dielectric residues" on the conductive pad. (Jin, col. 2, lines 59-61)(emphasis added). Thus, Jin cannot teach or suggest a "residue free opening" or "residue free contact opening" as recited in the presently claimed invention as metal residue may still remain. Further, Jin fails to disclose that the sidewalls surrounding the metal contact are residue free. (See, for example, Specification page 3, line 17 – page 4, line 4; Fig. 13

and Fig. 14). Instead, Jin discloses that the "overetch process is added to ensure that all pads are open and that no oxide residue remains on the pads." (Jin, col. 7, lines 52-54)(emphasis added).

Further, Jin teaches an overetch to remove oxide residue and acknowledges the main etch and overetch may induce charging damage. (Jin, col. 7, lines 50-56 and Specification, page 8, lines 1-7). Accordingly, Jin fails to teach or suggest a substantially damage-free metal-containing conductive pad as recited in each of the claims of the presently claimed invention.

Similarly, Wilson teaches a wet isotropic etch process to substantially remove the sacrificial metal layer and create a contact interface with a wider cross section. The process of Wilson does not include a cleaning step following the isotropic etch. Thus, any residue created by the isotropic etch step will be left in the contact opening, compromising the performance and durability of the contact ultimately deposited therein. Additionally, the application of a combination of nitric acid and phosphoric acid will not render the Wilson opening residue free. (Specification, page 8, lines 1-7).

The process of Jin in view of Wilson will not render a contact opening residue-free with a substantially damage-free metal containing conductive pad. The Jin process fails to remove metal residue and may induce charging damage to the device. The Wilson process also fails to completely remove residue. (Specification, page 8, lines 1-7)("mixtures of phosphoric acid and nitric acid were also found to be unacceptable for removal of the residue layer"). As neither Jin nor Wilson teaches or suggests a residue-free contact opening and a substantially damage-free conductive pad, the combination of Jin in view of Wilson will not result in residue-free contact openings of the presently claimed invention. Applicant respectfully requests that the rejection of claims 1 through 6 and 8 through 9 be withdrawn.

Furthermore, independent claims 1, 2, 5 and 6, of the presently claimed invention, each include similar limitations of an opening "extending from an upper surface of the dielectric layer to a metal-containing conductive pad" and having substantially parallel sidewalls *extending from the upper surface of the dielectric layer to the substantially damage-free metal-containing conductive pad.* Applicant respectfully submits that the proposed combination of Jin and Wilson fails to teach or suggest an opening in a dielectric layer having substantially parallel sidewalls extending from the upper surface of the dielectric layer to the substantially damage-free metal-containing conductive pad. Instead, Jin teaches a wet etch followed by an isotropic etch and

anisotropic etch to create a "Y" shaped opening. (Jin, col. 6, lines 37-39, Figs. 7 and 8). As stated, Jin also teaches a process that may induce charge damage. Similarly, Wilson expressly teaches a dry etch and an isotropic etch to create a "T" shaped void. (Wilson, col. 4, lines 19-21 and 34-36).

Applicant respectfully disagrees that Jin discloses a residue-free opening having substantially parallel sidewalls *extending from the upper surface of the dielectric layer to the substantially damage-free metal-containing conductive pad.* (Paper No. 20041222, page 2). Instead, Jin teaches or suggests an opening 26 over a metal contact pad 23. (Jin, Fig. 5, col. 7, lines 29-30). Jin teaches or suggests that the opening 26 is further etched twice to remove oxide residue. The first isotropic etch creates an opening clearly *having tapered sidewalls*. (Jin, Fig. 6, col. 7, lines 30-39). A second anisotropic etch does not completely remove the tapered portion 35, 36 of the sidedwalls. (Jin, Fig. 7). Accordingly, the wet etch followed by an isotropic etch and anisotropic etch creates a "Y" shaped opening. (Jin, col. 6, lines 37-39, Figs. 7 and 8). Jin fails to teach or suggest substantially parallel sidewalls *extending from the upper surface of the dielectric layer to the substantially damage-free metal-containing conductive pad* as recited in the claims of the presently claimed invention.

Applicant respectfully disagrees with the Examiner's statement that Jin teaches "a contact opening in a dielectric layer and a barrier layer, the semiconductor substrate having a substantially damage free metal-containing conductive pad under the dielectric layer and the barrier layer" and "the residues being removed from the contact opening (residues free)." Paper No. 20041222, page 2). Jin merely discloses that a "smaller amount of plasma etch time *reduces the possibility* that the integrated circuit will suffer defects during the contact pad opening process." (Jin, col. 2, lines 63-65). Thus, Jin does not teach that the contact pad is substantially free of charging damage. Further, Jin discloses a process that "minimize[s] dielectric residues on the at least one conductive pad." (Jin, col. 2, lines 56-59; claims 13 and 19). Further, while Jin states that no *oxide* residue remains on the *pads*, it fails to teach or suggest that metal-polymer residue is removed or that the sidewalls are residue free.

As the proposed combination of Jin and Wilson fails to teach or suggest every limitation of the presently claimed invention, applicant respectfully submits that independent claims 1, 2, 5 and 6 of the presently claimed invention, are not rendered obvious by Jin in view of Wilson.

Accordingly, applicant submits that claims 1, 2, 5 and 6 are allowable over the proposed combination of references.

Additionally, independent claims 3, 4, 8 and 9 of the presently claimed invention each include the similar limitation of a "metal polymer residue-free and oxide polymer residue-free opening in a dielectric layer and a metal-containing barrier layer". Applicant respectfully submits that the proposed combination of Jin and Wilson fails to teach or suggest such an opening. Jin only discloses dielectric layers surrounding a via and lacks disclosure of a metal-containing barrier layer. Wilson discloses a sacrificial metal layer 14 above first metal layer 13. However, Wilson teaches a dry etch which creates residue in a via followed by a wet isotropic etch comprising both nitric acid and phosphoric acid. (Wilson, col. 4, lines 34-38). As noted, mixtures of nitric acid and phosphoric acid (rather than independent application) are unacceptable for complete removal of residue layers. (Specification, page 8, lines 1-7). Thus, the via opening in Wilson is not metal polymer residue-free and oxide polymer residue-free.

As the proposed combination of Jin and Wilson fails to teach or suggest every limitation of the presently claimed invention, applicant respectfully submits that independent claims 3, 4, 8 and 9 of the presently claimed invention, are not rendered obvious by Jin in view of Wilson. Accordingly, applicant submits that claims 3, 4, 8 and 9 are allowable over the proposed combination of references.

Double Patenting Rejection Based on U.S. Patent No. 6,747,359

Claims 1 through 6, 8 and 9 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1 and 2 of U.S. Patent No. 6,747,359. In order to avoid further expenses and time delay, Applicant elects to expedite the prosecution of the present application by filing a terminal disclaimer to obviate the double patenting rejections in compliance with 37 CFR §1.321 (b) and (c). Applicant's filing of the terminal disclaimer should not be construed as acquiescence in the Examiner's double patenting or obviousness-type double patenting rejections. Attached are the terminal disclaimer and accompanying fee.

CONCLUSION

Claims 1-6 and 8-9 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicant's undersigned attorney.

Respectfully submitted,

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Date: March 28, 2005
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Document in ProLaw